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WATER TABLE DEPTH AND GROUND WATER SALINITY IN THE NONIRRIGATED AREA OF THE LOWER RIO GRANDE VALLEY OF TEXAS

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WATER TABLE DEPTH AND GROUND WATER SALINITY IN THE NONIRRIGATED AREA OF THE LOWER RIO GRANDE VALLEY OF TEXAS[1]

by R. R. Allen, L. R. Ussery, and B. M. Taylor [2]

The Lower Rio Grande Valley of Texas is known for its intensively irrigated agriculture. However, more than one-half of the 1,500,000 acres of arable land is not irrigated. Much of the dryland, approximately 350,000 acres, lies between the irrigated land on the west and the Gulf of Mexico, with the eastern boundary meandering in a north-south direction between 10 and 20 miles from the coast (fig. 1).

About 150,000 acres of this nonirrigated cropland, hereinafter named the problem area, are affected by varying degrees of soil salinity. Figure 2 shows the plant-growth pattern typical of the problem area where saline soil conditions limit production.

In 1958 local landowners and operators of the problem area, working through the Willacy-Hidalgo Soil Conservation District and the Joint Research Committee of the Lower Rio Grande Valley Soil Conservation Districts, requested research assistance from the U.S. Department of Agriculture and subsequently made land and other facilities available to the Soil and Water Conservation Research Division, Agricultural Research Service, for a study of the salinity problem.

Investigations were conducted from 1959 through 1963 to determine the extent and severity of salinity problems within the problem area; to relate water table, soil, topographic, and other measurable factors with the occurrence and severity of the salinity problem; and to study the complex factors related to salinity and drainage problems. This report presents the results of some of these investigations.

GENERAL FEATURES AND HISTORY OF THE PROBLEM AREA

Climate

The climate of the problem area is classified as marine (8)[3] semitropical, and semiarid. Average annual rainfall at Raymondville, near the center of the area, is 26.5 inches; average rainfall distribution by months ranges from a low of 1.15 inches in February to 4.65 inches in September (9). Much of the rainfall is received from August through December. There is a decrease in concentration of salts in rainfall with distance from the coastline (4). Appendix table 1 compares rainfall during the study period with a 30-year average (1931-60). The average

[1] Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department of Agriculture, Weslaco, Tex., in cooperation with the Texas Agricultural Experiment Station.

[2] Agricultural engineer, formerly agricultural engineer, and formerly core drill operator, respectively, Soil and Water Conservation Research Division.

[3] Underscored numbers in parentheses refer to Literature Cited, p. 18.

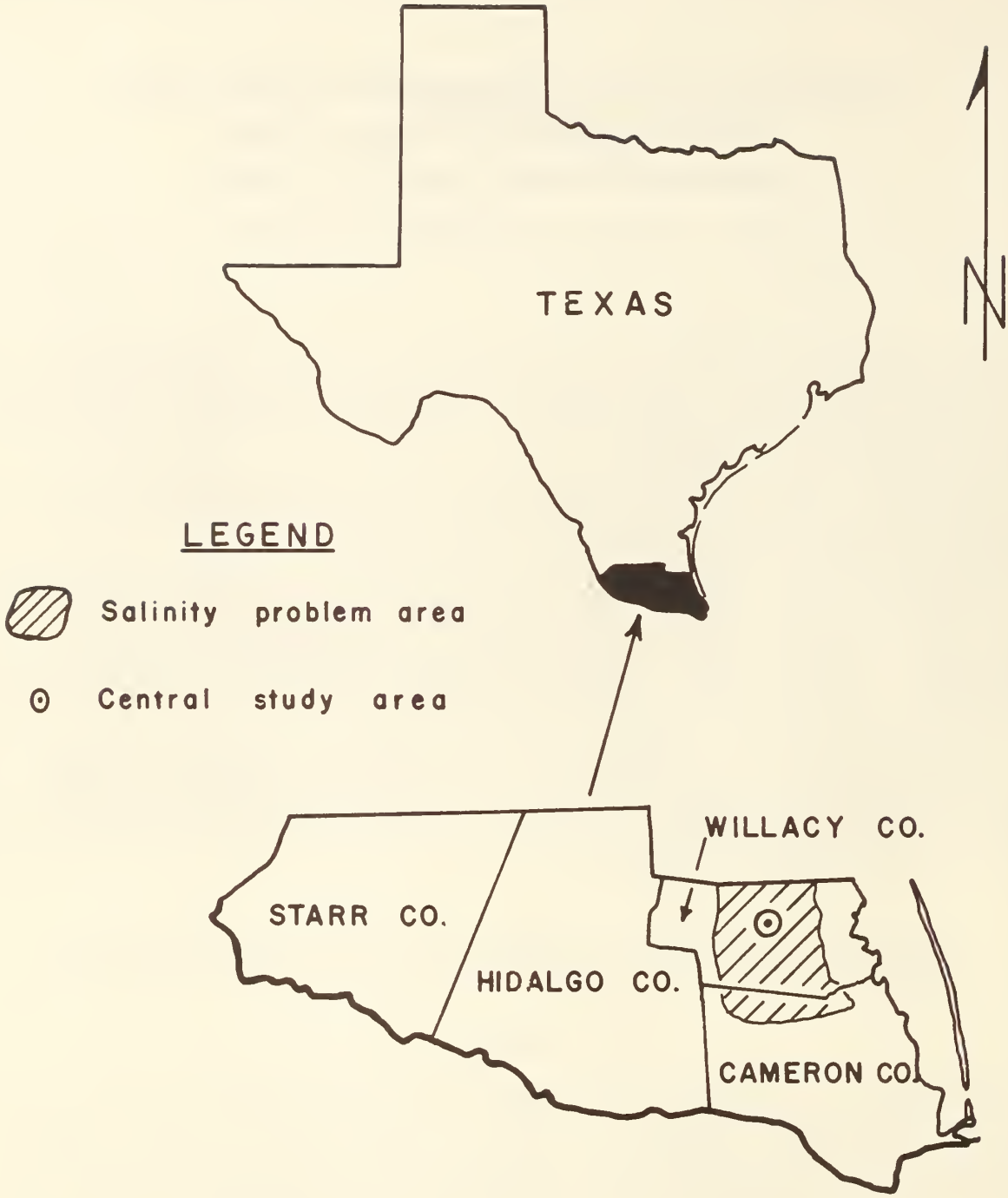


Figure 1.--Lower Rio Grande Valley shown on map of Texas.

Figure 2.--Light-colored areas are soils affected by salinity.

monthly temperature ranges from 59° F. in January to 84° in July, with a frost-free growing season of more than 300 days. Average relative humidity is approximately 70 percent.

Geology and Soils

The surface formation is described as alluvium deposited by the Rio Grande, which has meandered through the area during its development. The formation consists of complexly interbedded layers of clay, silt, and sand. Changes occur over short distances, vertically and laterally. Older underlying formations dip toward the coast and outcrop to the west in belts parallel to it (1).

The soils are predominantly clay loams and sandy clay loams developed from deltaic parent materials.

Topography

Surface topography is flat to gently rolling, with a general slope to the northeast of approximately 1 foot per mile. There is no well-defined surface drainage pattern. The land surface contains numerous shallow depressions separated by minor ridges. Water is ponded in the depressions during high-intensity storms until it percolates into the soil or evaporates from the surface. Elevation of the problem area is from 20 to 40 feet above mean sea level.

History of the Problem

Most of the land presently under cultivation was cleared of native vegetation between 1910 and 1920. Much of the land is still owned by families who put the land under cultivation. Some of them report early evidence of what were then called "hot spots," a term applied to areas evidencing reduced growth or drougthy conditions. No serious salinity problem was apparent, however, and crops were generally uniform. Cotton yields of 1 bale and grain sorghum yields of 4,000 pounds per acre were common in seasons of favorable rainfall.

Since 1950 the salinity problem has increased in severity and in areal extent. The effects on production costs are magnified by the pattern of salt-affected areas. They generally occur in narrow strips that meander at random across the regularly divided fields. Under present systems of ownership and management it is impractical to cut out the saline areas for separate treatment. Thus, the operation costs of the entire field must be borne by production from only the unaffected areas.

Earliest mention of soil salinity investigations in the problem area is found in a report of the soil survey of Willacy County conducted in 1926 (5). According to that report, which included nearly 100 studies of 5-foot profiles of soil in various parts of Willacy County, most soil salinity problems were limited to the area east of the presently cultivated land. This area is generally less than 15 feet above sea level. Some profiles sampled within the present problem area, however, did show salinity increasing with depth to 5 feet. A water table survey of Willacy County was started in December 1935 and terminated in August 1936 (10). More than 1,000 test holes were drilled to depths of 15 to 25 feet. A water table was noted at 6 to 10 feet under much of the present problem area.

INVESTIGATION PROCEDURES

Study Areas

An area of approximately 1,800 acres, 7 miles east of Raymondville (fig. 3), was selected for characterization of the water table and salinity problems. This area, hereinafter named the central study area, was selected for three reasons: (1) local landowners were interested in cooperating in the research effort; (2) most of the soil types within the overall problem area were represented; and (3) an outlet drain was available.

Ground Water Table Investigations

Observation wells were installed on a $\frac{1}{4}$-mile grid pattern over the central study area. The observation wells, cased with 3-inch-diameter steel tubing, were placed 9 feet deep. Piezometers, $\frac{3}{8}$-inch-diameter pipe, were placed 10 feet deep on a $\frac{1}{2}$-mile grid pattern.

In addition, piezometer batteries, consisting of 6-, 10-, and 20-foot pipes, were installed at key locations (fig. 3). Piezometers were installed by the jetting technique (7), which provided a soil profile log of each location. Ground water samples were obtained from the lower end of the piezometers through a plastic tube inserted through the top. Vacuum was applied to the tube to lift the water sample.

Water level recorders and recording rain gages were installed at selected locations to obtain uniform coverage and a continuous record of water table fluctuation and rainfall (fig. 3). Ground water levels were measured monthly and 2 to 3 days after amounts of rainfall great enough to cause a water table rise.

Piezometer transects were installed at selected saline spots to investigate local water table differences in relation to soil salinity. Lines extended across saline sites into adjacent unaffected soils on both sides.

Water table observation points were added outside the central study area to determine regional water table characteristics over the problem area. Ground water samples were collected annually, in November, from observation wells and piezometers for salinity analysis.

A test well was installed 7 miles east and 1 mile north of Raymondville, in the central study area, to determine the water transmission characteristics of the underlying sand formation (fig. 3). The well consisted of a 6-inch-diameter, 15-foot-long stainless steel screen attached to the lower end of a steel casing. The screen extended through the sand stratum, 12 to 27 feet below the soil surface.

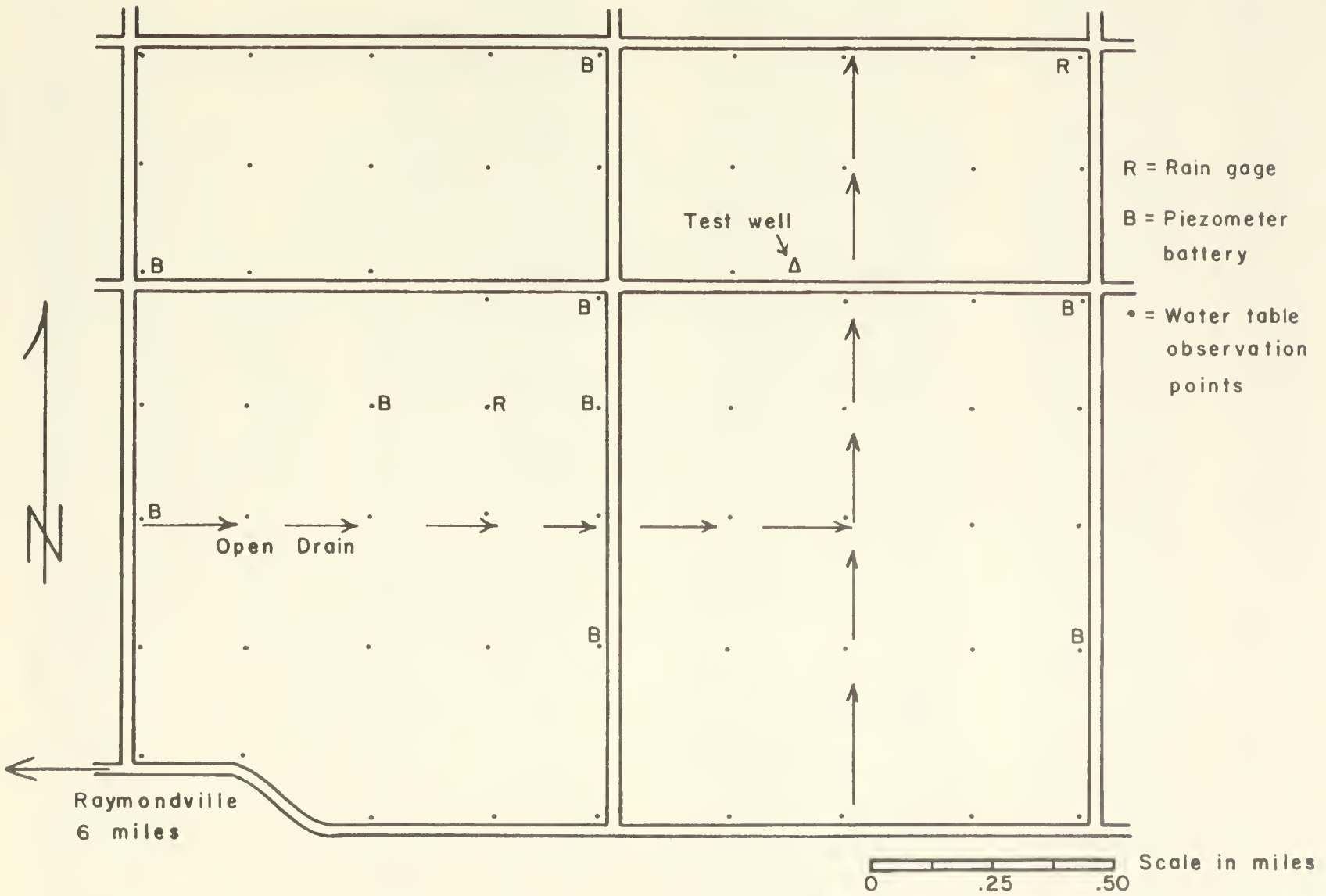


Figure 3.--Map of the 1,800-acre central study area.

Soil Investigations

The soil investigations consisted of studies of surface profiles and deep exploration drilling.

Surface Profiles

Ten locations, four in Raymondville clay loam and six in Willacy fine sandy loam, were sampled in November 1959 for physical and chemical characterization of soil profiles within the central study area (2). Sites were selected in pairs within soil series to provide samples from saline areas and adjacent unaffected areas, as shown by crop conditions. Trenches 24 inches wide, 12 feet deep, and 10 to 20 feet long were excavated with a backhoe at each sampling site. Samples for laboratory analysis were collected from the different horizons as delineated in the soil survey.[4]

Exploration Drilling

An exploration drilling rig with core-sampling apparatus was used for defining the limits of and collecting samples from different soil formations lying at depths greater than 12 feet below the surface. Several holes were drilled approximately 50 feet deep within the central study area and in the immediately surrounding area. Exploration holes were drilled to a depth of 50 to 75 feet along a line extending from a point 1 mile south of Lasara east to the Laguna Madre at intervals of approximately 2 miles (fig. 6). This line reaches across the 150,000-acre problem area from west to east. The drilling was done along the right-of-way of Farm Road 490 to its termination at a point 2 miles south of the 1,800-acre study area, thence eastward to the edge of the cultivated land 1 mile east of Willamar, and then at selected locations within El Sauz ranch, which includes all of the native rangeland between the eastern boundary of the cultivated land and the Laguna Madre.

Crops

Aerial photographs of the central study area and the surrounding lands--a total of approximately 15 square miles--were taken in 1958 and 1959 during July while most of the land was in cotton and grain sorghum. Photographs were made with sufficient overlap to allow stereoscopic examination for delineation of areas of restricted crop growth. These photographs provided a record of crop conditions from which to measure changes resulting in enlargement or reduction of the saline areas. Soil analyses and crop growth condition appraisals were made in sufficient detail for interpretation of the aerial photographs.

Aerial photographs were made after 1959 at intervals throughout the crop season and following periods of high-intensity rainfall.

RESULTS AND DISCUSSION

Ground Water Table

Records for the 5-year study period show a seasonal water table fluctuation related to rainfall. Figure 4 shows the water table elevation and monthly rainfall near the center of the central study area for the 1959-63 period.

Rainfall from high-intensity storms during September and October of 1958 totaled 17 inches. The soil profile was completely saturated and water ponded on the surface for several weeks.

[4] Soil classifications and profile descriptions were made by soil scientists of the Soil Conservation Service.

Water ponded in depressions was at the elevation of the water table. Figure 5 shows the slow recession of the water table following its extremely high peak in October 1958. In 1959 rainfall was less than 18 inches and the water table slowly receded from the 1958 high to a depth of more than 7 feet below the ground surface in early October 1959. The water table remained more than 6 feet below the ground surface until the fall of 1960 when high-intensity rainfall produced a rise (fig. 5), similar to that which occurred in 1958.

The water table in 1961 continued to drop until storms accompanying hurricane Carla in September produced a rise to an elevation of 1 to 2 feet below the ground surface. Rainfall was less than normal in 1962 and the water table in the fall of 1962 was more than 8 feet below the ground surface in most of the problem area. The water table remained more than 7 feet below the surface through August 1963 until fall rains brought a rise to the 3- to 4-foot depth in December. The 1963 total rainfall was normal, although the first 4 months of the year were very dry. September-through-December rainfall totaled 14 inches.

Water Table Gradient

The average overall water table gradient over the problem area is approximately 1 foot per mile to the northeast and is generally parallel to the ground surface slope. The water table slope toward the coastline indicates that there is no salt water encroachment from the Gulf of Mexico. No significant differences in water table elevation that could be related to the occurrence of salinity were detected. No piezometric pressure was detected in the study area.

Figure 7 shows the water table elevations under the entire problem area as measured on May 1, 1961. This measurement followed a period of relatively low rainfall and the water table should have been stabilized to its normal gradient. Figure 5 shows the water table elevation and gradient from west to east across the central study area at different times during a single season. The lower water table level on August 1, 1960, reflects spring and summer consumptive use. The higher water table level, December 23, 1960, shows the water table response to 21.5 inches of rainfall received during the interim period.

The La Sal Vieja area (fig. 7) is an exception to the regional water table gradient. In this case the slope is into the lakes. The La Sal Vieja Basin, consisting of two lakes, impounds the surface runoff from the surrounding area; this runoff then evaporates, leaving the lakes with a high salt content. The electrical conductivity of the shallow eastern lake, with greater evaporation per unit volume, averages 130 mmhos./cm. The electrical conductivity of the water from the deeper western lake averages 50 mmhos./cm.

Water Table Fluctuation

Water table rises above a certain level result from rainfall in excess of the amount that the soil can hold up to that level. The overall water table response from rainfall averaged 1 foot of rise for each 1.5 inches of rainfall after the profile had become saturated. This indicates a specific yield of 12.5 percent by volume for the profile down to the 8-foot depth. The general water table decline, following high winter peaks, averages 0.1 foot per week during early spring months and increases through late spring and summer consumptive use periods (fig. 4).

Early spring field preparation is hampered and planting is delayed when water tables are within approximately 3 feet of the soil surface. This condition occurred in early 1959 and 1961 after extreme winter water table peaks. This extreme peaking indicates a need for drainage during these periods to help lower water tables to more acceptable levels. Lyles and Fanning (6) contend that nonirrigated grain sorghum production is related to the elevation of the water table at seeding time. Therefore, the presence of a water table may have beneficial as well as harmful influences. This indicates that the water table should be deep enough so that the fringe of the capillary moisture zone does not reach the soil surface, yet shallow enough for plant roots to reach the capillary moisture zone. The optimum depth for these conditions appears to be 4 to 6 feet.

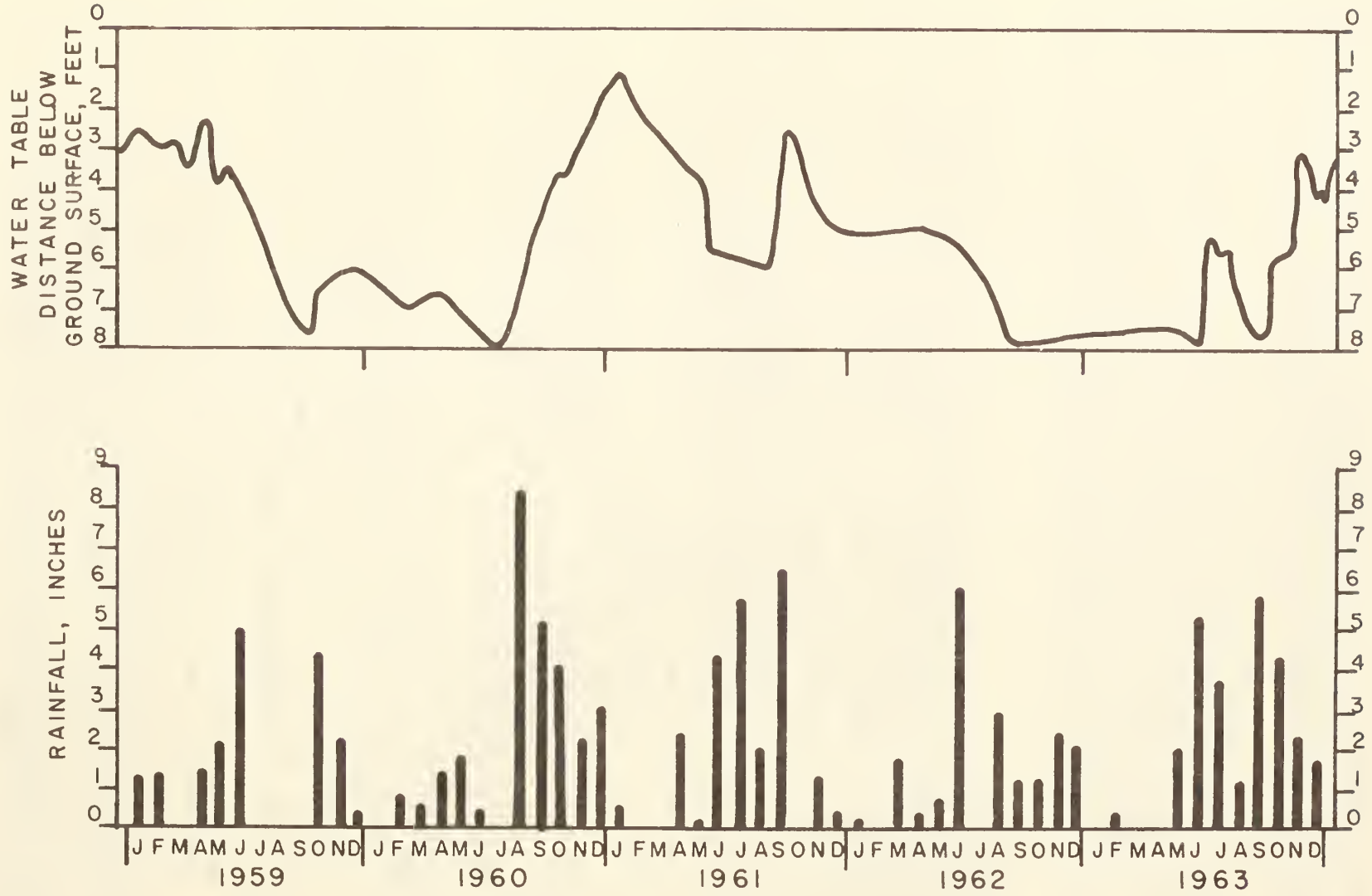


Figure 4.--Monthly rainfall and water table fluctuations (1959-63).

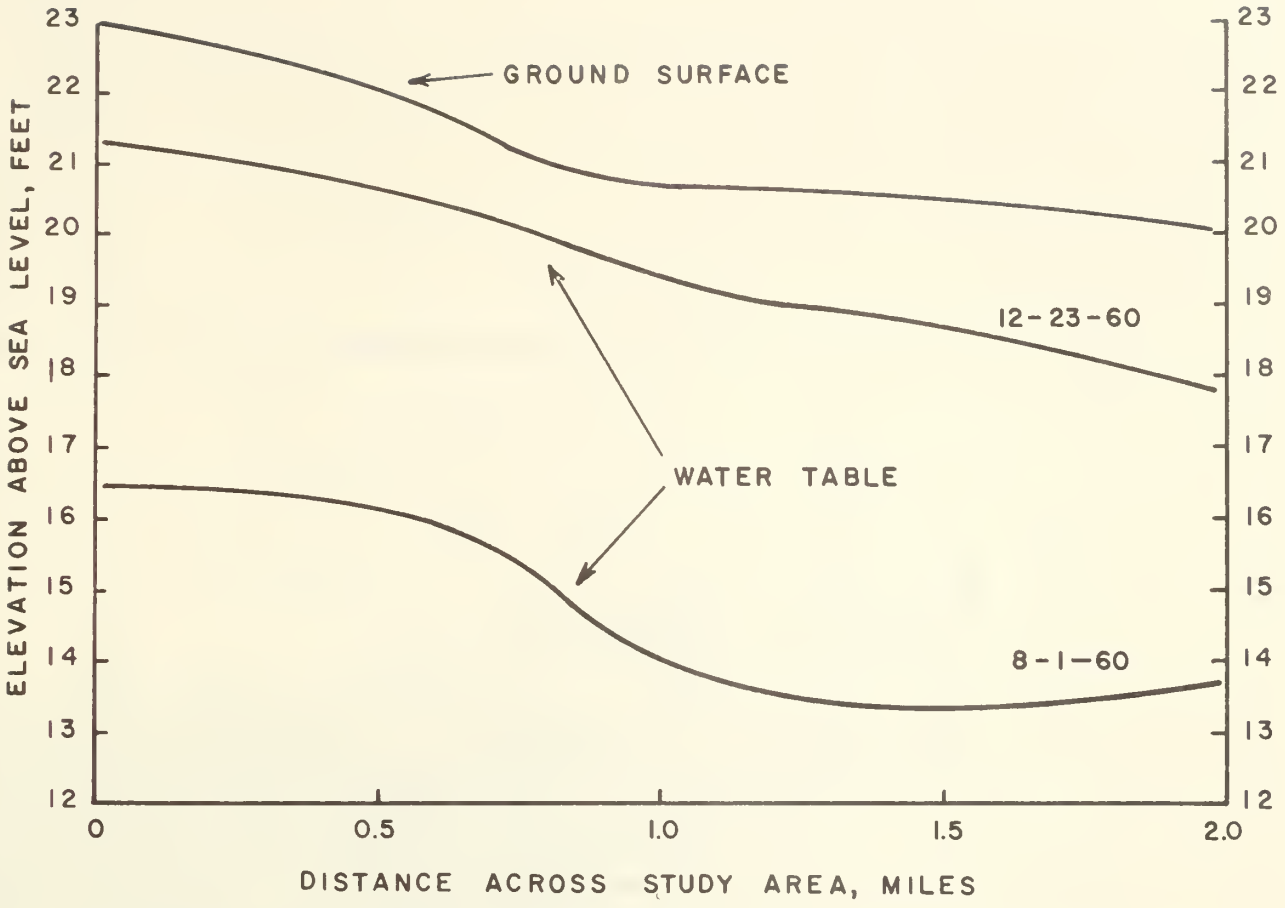


Figure 5.--Ground surface and water table profile across the 1,800-acre central study area (west-east).

Ground Water Chemistry

The salinity of the shallow water table varies considerably with time and location, depending on the amount of percolation from the soil surface and the salinity status of the soil profile through which the percolate has passed. Deeper ground water such as that in the underlying sand aquifer has a more consistent high salinity level. Appendix table 2 shows that the electrical conductivity of the ground water increased with depth at three locations whose surface soil ranged from nonaffected by salinity to severely salt-affected.

Electrical conductivity of samples collected from piezometers placed 10 feet below the surface within the central study area ranged from 1.2 to 42.0 mmhos./cm. (fig. 8). A similar range of salinity was found in samples collected from piezometers located over the large area of the extended water table study. Electrical conductivity of many samples exceeded 25 mmhos./cm. The salt concentration in the ground water increases with depth to between 20 and 30 feet below the surface where electrical conductivity of the water is generally between 30 and 45 mmhos./cm. (20,000 to 30,000 p.p.m. of dissolved solids).

Ground water with a low salt concentration apparently stagnates on top of the deeper, more saline water. Variation in salt content of shallow ground water over short distances indicates slow lateral ground water movement.

Ground water pumped from the test well (fig. 3), penetrating the 15-foot-thick sand formation, had a consistently high electrical conductivity over a 2-month period (appendix table 3). This is further indication that water in the sand stratum is more uniform in salt content than is the shallow water table.

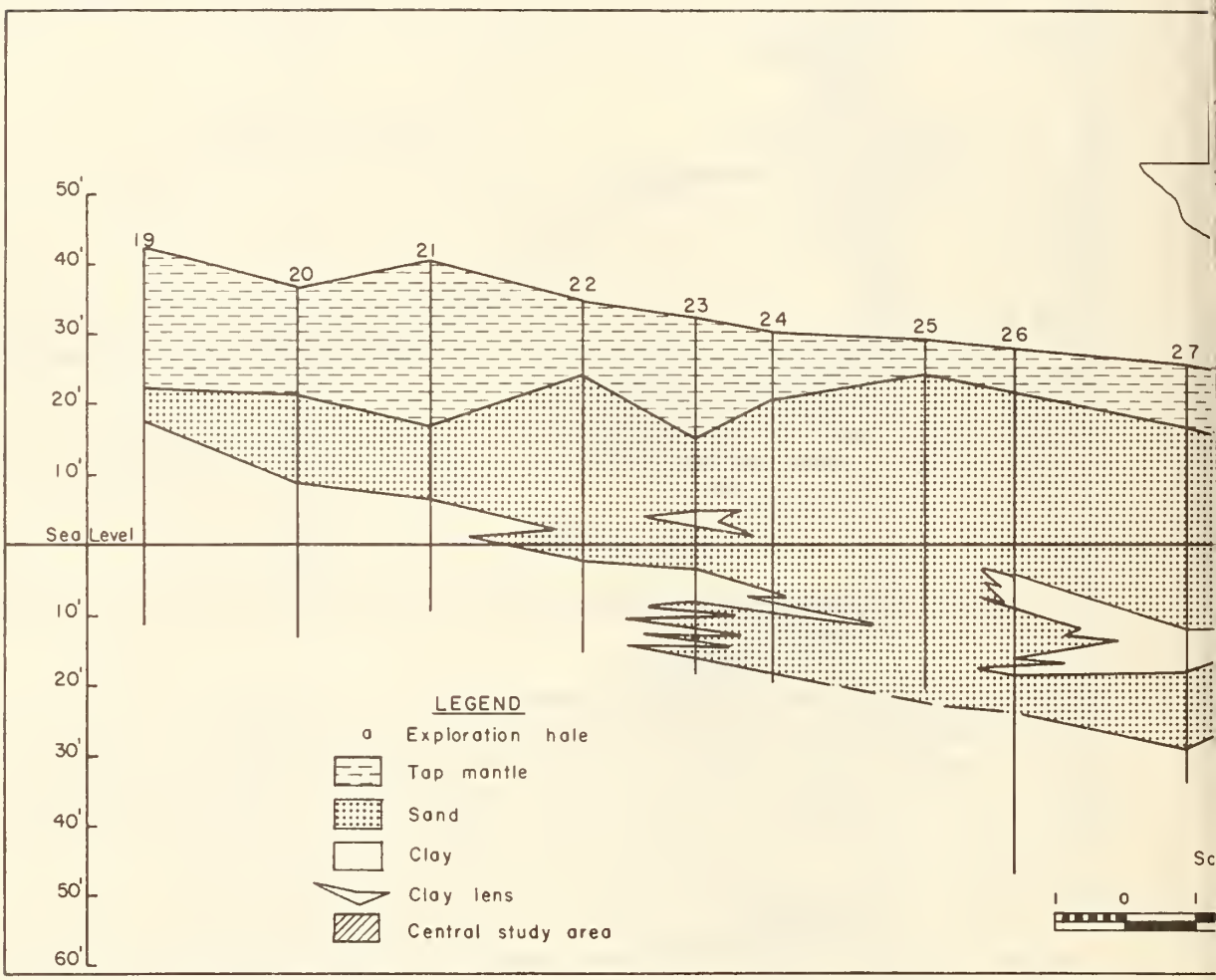
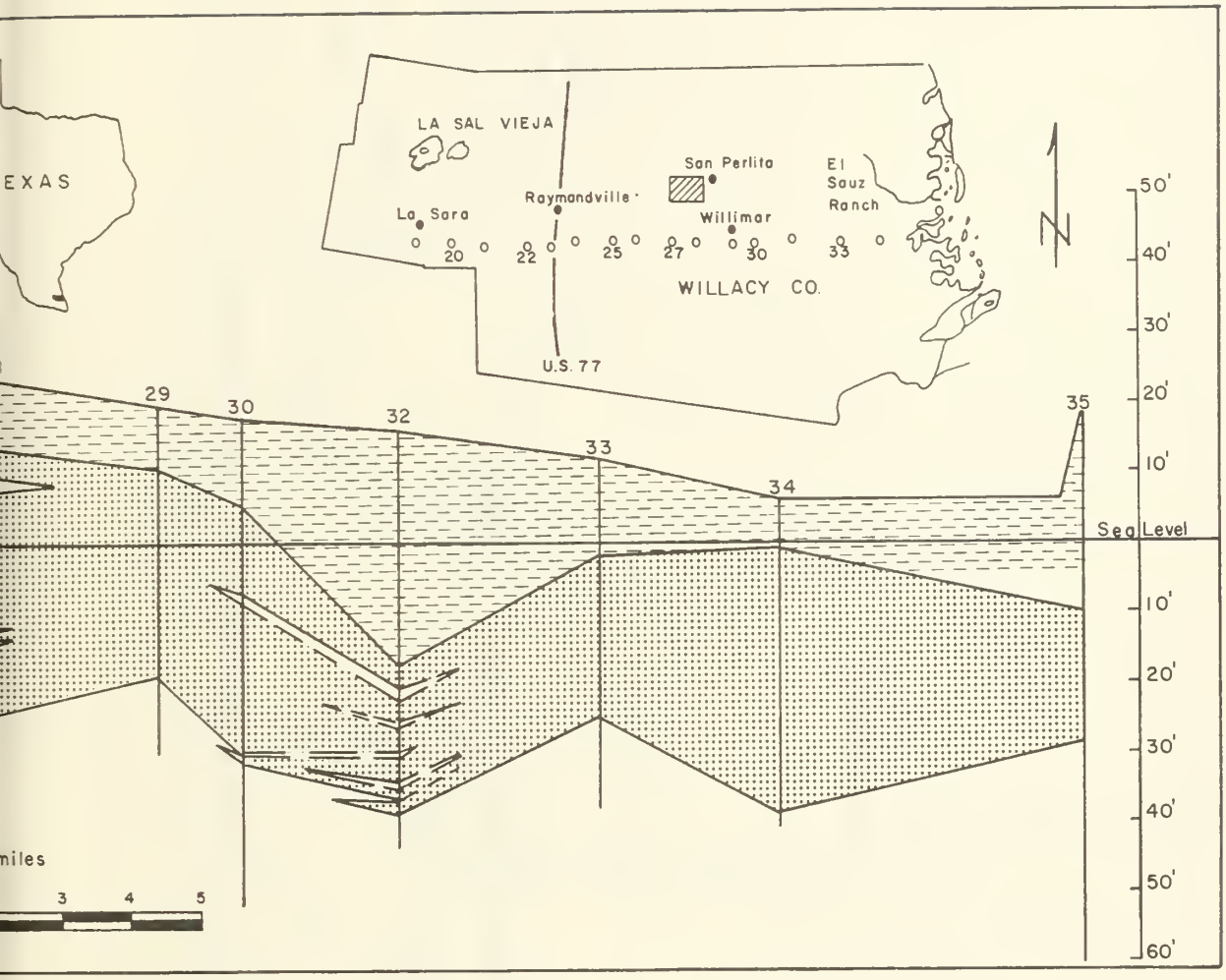


Figure 6.—Log of exploration ho



om transect across the problem area.

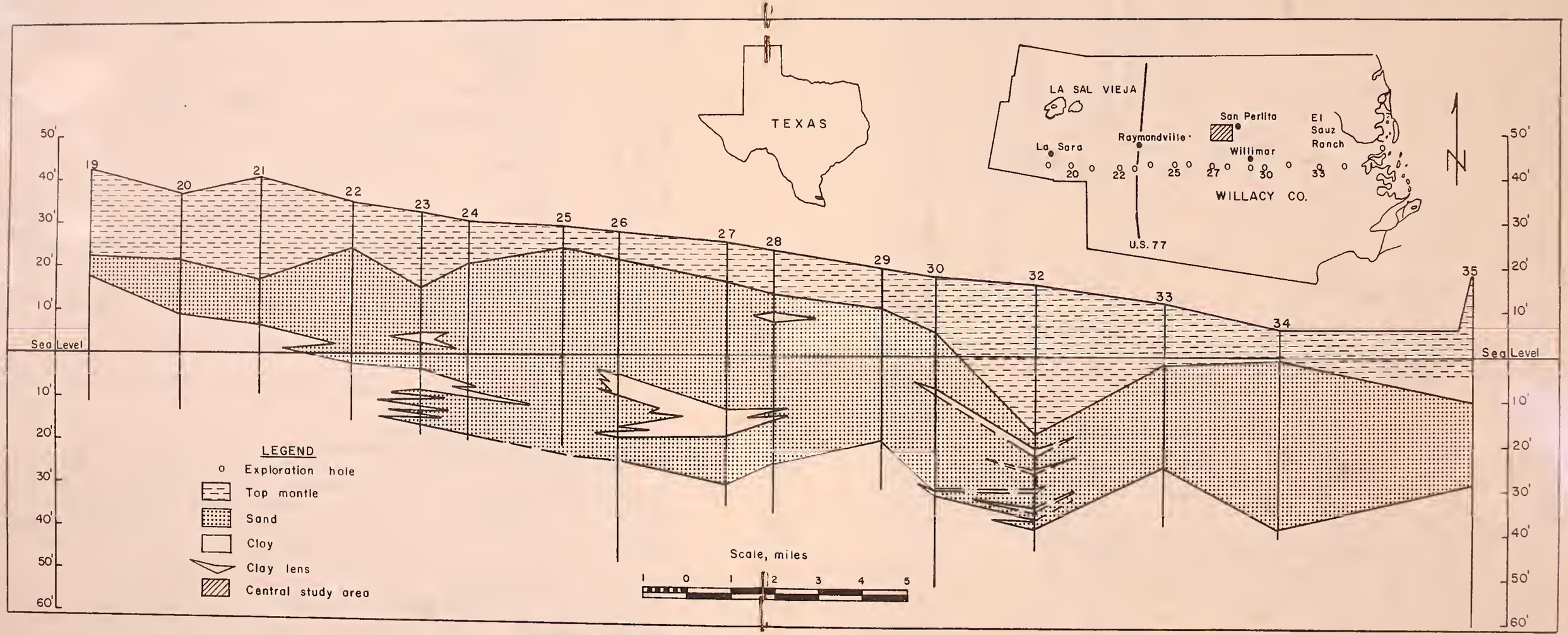


Figure 6.—Log of exploration holes from transect across the problem area.

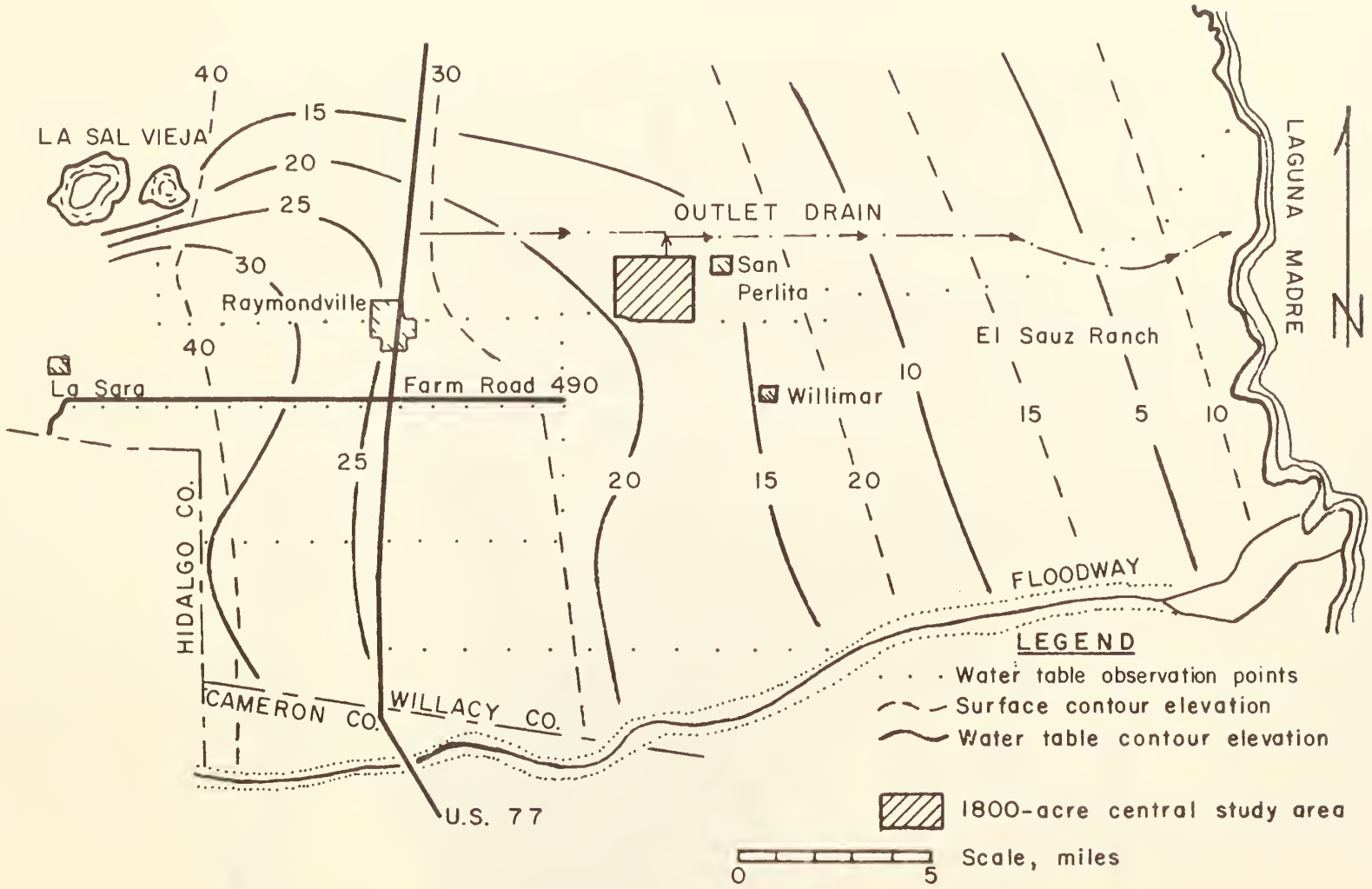


Figure 7.--Map of 150,000-acre salinity problem area with ground surface and water table elevation contour lines.

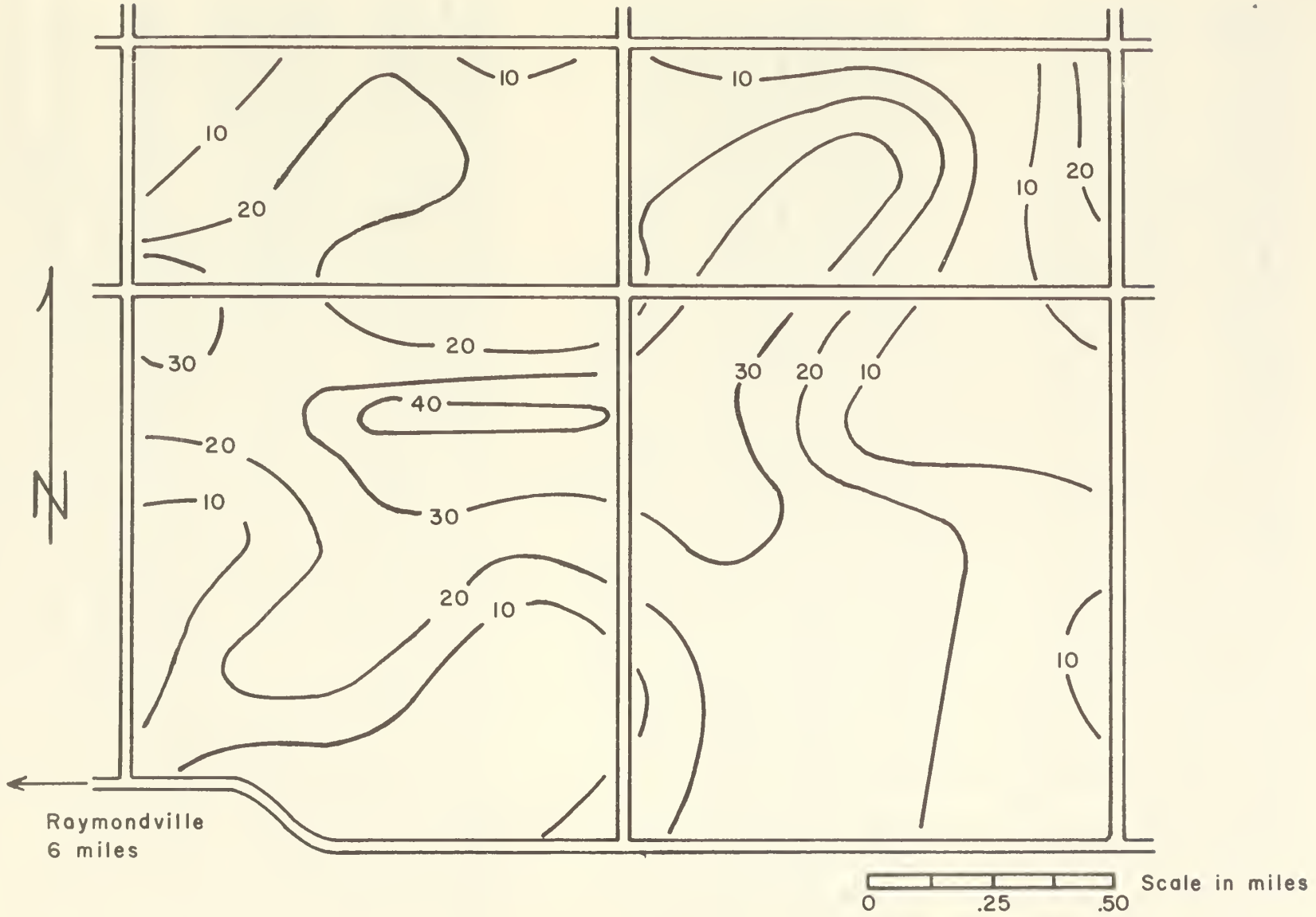


Figure 8.--Electrical conductivity (mmhos./cm.) of ground water 10 feet below ground surface in the 1,800-acre central study area (Dec. 1961).

Surface water samples contained very low concentrations of harmful salts ($EC_e < 3.0$ mmhos./cm.) with the exception of samples collected from depressions or ditches in which the water surface was below the elevation of the surrounding ground water table. Water standing on the surface of severely saline areas several days after high-intensity rainfall did not differ significantly from that ponded on unaffected areas.

Some natural impoundments had reportedly become salty since 1958, when heavy rainfall completely saturated the soil profile and raised the ground water table to the ground surface in many places. A lake $1\frac{1}{2}$ miles south of Willamar, typical of many in the area, was sampled in June 1959. Electrical conductivity was 24.0 mmhos./cm. Investigation showed the water table surrounding the lake to be higher than the elevation of the lake surface, indicating flow of ground water into the lake.

Hydraulic Conductivity

Flow rates and the drawdown pattern from the test well provide data to determine the hydraulic conductivity (K) of the underlying sand formation. Thiem's derivation (11) of Darcy's fundamental equation was used to compute K and the rate of lateral ground water movement. The average K was approximately 400 gal./ft.^{2}/day after the drawdown pattern stabilized. With the general hydraulic gradient of 1 foot per mile, a sand porosity of 40 percent, and a K of 400 gal./ft.^{2}/day, the rate of lateral water movement within the sand strata is calculated to be approximately 10 feet per year. Rate of lateral movement is directly related to hydraulic gradient. Temporary local gradients of up to 5 feet per mile will increase the rate of lateral water movement to only approximately 50 feet per year. This is evidence that water movement into the problem area from the west has little measurable effect upon water table fluctuation. Although the sand formation is relatively permeable and appears physically capable of rapid lateral water movement, the low hydraulic gradient is a major limiting factor.

Soils

Surface Profiles

Appendix table 4 presents representative salinity and particle size distribution data obtained from pit samples at adjacent saline and nonsaline sites on a Raymondville clay loam, one of the major soils in the salinity problem area. Saline and nonsaline sites were selected on the basis of plant growth. Detailed chemical and physical properties of 10 sample sites are included in tabular form in another publication (2).

The soil salinity level at the saline site was extremely high in the surface 0- to 2- and 2- to 5-inch depths and decreased to a near constant level at the 15- to 27-inch depth. Soil salinity at the nonsaline site was low in the 0- to 3-inch depth and increased with depth below 30 inches.

The clay percentage was greater at the saline site at a depth below 5 inches and gradually increased to 50 percent at the 100-inch depth. The nonsaline site was high in sand content at the 100-inch depth. These data are representative of the salinity problem area in that saline soil areas usually contain more clay below 1 foot than do nonsaline areas.[5]

The high surface soil salinity at the saline site apparently is the result of upward moisture movement associated with surface evaporation. Soil areas with higher clay contents are subject to higher capillary rise above the water table and lower infiltration rates.[6]

[5] Carter, D. L., and Wiegand, C. L., research soil scientists, Soil and Water Conserv. Res. Div., Agr. Res. Serv., U.S. Dept. Agr., at Twin Falls, Idaho, and Weslaco, Tex., respectively. Unpublished data, 1965.

[6] Wiegand, C. L., Lyles, L., and Carter, D. L., research soil scientist, research agricultural engineer, and research soil scientist, respectively, Soil and Water Conserv. Res. Div., Agr. Res. Serv., U.S. Dept. Agr., at Weslaco, Tex., Manhattan, Kans., and Twin Falls, Idaho. Unpublished data, 1965.

The water table at the sampling sites was approximately 2.5 feet deep in February 1959. Crop use and evaporation gradually lowered the water table to 7 feet during the summer, where it remained until sampled in November. The high spring water table followed by the relatively dry summer and fall was probably an important factor in the high salt accumulation near the soil surface found at the saline site (appendix table 3). The high salt accumulation near the soil surface of the saline site is the reason for restricted seed emergence (3).

Exploration Drilling

The exploration drilling revealed a number of features of the shallow sand strata underlying the area (fig. 4) that could contribute to an understanding of the overall salinity problem:

(1) The sand formation varies in thickness and depth below the ground surface and appears continuous over the study area. Depth ranges from 5 to 30 feet and formation thickness ranges from 10 to 50 feet.

(2) The sand formation is thickest near the center of the salinity problem area.

(3) The sands near the eastern edge of the salinity problem area are heterogeneous, being interfingered with the overlying soil mantle and underlying clay formation. This probably restricts lateral flow of ground water out of the area.

(4) The limited depth to the top of the sand formation may require special engineering considerations for deep open drains that may be constructed for relief of the drainage problems of the area.[7] The low ground surface gradient toward the coastline and limited elevation above sea level also influence drain design.

(5) The sand formation was saturated throughout the area and depths studied. No layers were under artesian pressure.

SUMMARY AND CONCLUSIONS

A 5-year study (1959-63) to characterize ground water and salinity conditions applicable to approximately 150,000 acres in the dryland area of the Lower Rio Grande Valley of Texas has revealed:

1. The climate is semitropical and annual rainfall averages 26.5 inches, with distribution ranging from 1.1 inches in February to 4.6 inches in September. Much of the rainfall is received from September through December.

2. The ground surface formation is alluvium from the Rio Grande consisting of interbedded layers of sand, silt, and clay. The soils are predominantly clay loams and sandy clay loams developed from deltaic parent materials.

The surface topography is flat to gently rolling. There is no well-defined drainage pattern. Water is ponded in depressions during high-intensity storms until it percolates into the soil or evaporates.

3. The overall water table slopes northeastward toward the coast approximately 1 foot per mile and is generally parallel to the ground surface. The water table slope toward the coastline indicates no salt water encroachment from the Gulf of Mexico.

The water table, influenced by rainfall distribution and moisture use by crops, fluctuates throughout the year. The water table generally rises with autumn rains and falls after the spring and summer consumptive use season. No artesian pressure or evidence of measurable

[7] Allen, R. R., and Myers, V. I., agricultural engineer and research agricultural engineer, respectively, Soil and Water Conserv. Res. Div., Agr. Res. Serv., U.S. Dept. Agr., at Weslaco, Tex. Unpublished data, 1965.

water movement into the salt-affected area from the irrigated area to the southwest has been found.

Water table response averages 1 foot of rise for each 1.5 inches of rainfall after the soil profile has become saturated.

4. The ground water salt concentration is variable near the surface, increases with depth, and is generally uniformly high at depths below 20 feet. The range in salinity of the upper ground water is comparable to the difference in soil salinity between saline and non-saline areas.

5. High water tables in the early spring, such as occurred in 1959 and 1961, increase the hazard of soil salinization and can delay tillage and planting operations in some areas. This condition indicates a need for drainage during such periods. However, crops appear to use some moisture from the water table. The optimum depth of the water table for both salinity control and crop use appears to be 4 to 6 feet.

6. The salinity problem area is underlain by a continuous, saturated sand formation of varying depth (5 to 30 feet) and thickness (10 to 50 feet). The sand formation has a relatively high permeability (400 gal./ft.^{2}/day) but lateral water movement is slow because of the low hydraulic gradient.

7. The shallow depth to the sand formation in some areas, low land surface gradient, close proximity to the coastline, and limited elevation above sea level may require special engineering applications in deep open drain construction.

8. Salt-affected soil areas occur at random without a distinct pattern, extend across field boundaries, usually contain more clay below a depth of 1 foot, and are subject to greater capillary rise above the water table than are nonaffected areas.

9. There is severely limited or no crop production on as much as 25 percent of the area of some fields because of high soil salinity. The irregular shape and distribution of salt-affected areas make it impractical to separate them for different management practices. Thus the operation costs of the entire field must be covered by production from nonaffected areas.

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APPENDIX

Table 1.--Monthly rainfall, 1959 through 1963, 7 miles east and 1 mile north of Raymondville, Texas

Month	1959	1960	1961	1962	1963	Monthly average[1]
	Inches	Inches	Inches	Inches	Inches	Inches
Jan.	1.30	0	0.39	0.19	0.13	1.83
Feb.	1.32	.80	0	0	.33	1.15
Mar.	.21	.65	0	1.68	.04	1.30
Apr.	1.38	1.50	2.43	.33	0	1.45
May	2.09	1.85	.21	.72	1.94	3.48
June	4.94	.35	4.10	6.05	5.30	2.46
July	0	.25	5.95	0	3.75	1.94
Aug.	0	8.50	1.83	2.89	1.17	3.00
Sept.	0	5.15	6.91	1.22	5.74	4.65
Oct.	4.27	4.07	.13	1.21	4.31	2.57
Nov.	2.02	2.50	1.85	2.45	2.23	1.37
Dec.	.40	3.05	.48	2.04	1.76	1.33
Total	17.93	28.67	24.28	18.77	26.70	26.53

[1] 30-year average, 1931-60(9).

Table 2.--Electrical conductivity (EC_e X 10^3) of water from different depths below ground surface

Depth below surface	Salinity category of surface soil[1]		
	Nonaffected	Moderately affected	Severely affected
Feet	Mmhos./cm.	Mmhos./cm.	Mmhos./cm.
6	2.2	8.0	30.0
10	5.2	35.0	40.0
20	18.5	40.0	42.0

[1] Salinity categories based upon plant growth.

Table 3.--Salinity of ground water pumped from a depth of 27 feet in a drain test well, September and October 1960, 7 miles east and 1 mile north of Raymondville, Tex.

Date	EC_e	Na	Ca	Mg
	Mmhos./cm.	Meq./l.	Meq./l.	Meq./l.
9/1/60	41.0	340.7	63.0	99.0
9/12/60	42.0	352.9	63.2	98.8
9/23/60	43.1	365.0	63.2	100.2
10/4/60	43.0	372.2	64.4	99.2
10/18/60	43.9	372.2	64.4	99.2
10/31/60	43.2	376.4	60.8	93.2

Table 4.--Chemical and physical characteristics of a Raymondville clay loam profile at adjacent saline and nonsaline sites in the central study area

Horizon	Depth	ECe[1]	Ca	Mg	Na	Sand	Slit	Clay
	Inches	Mmhos./cm.	meq./ 100 gm.	meq./ 100 gm.	meq./ 100 gm.	Percent	Percent	Percent
Saline site								
Ap1	0-2	90.0	13.20	4.85	12.92	50.82	22.75	26.43
	2-5	50.0	8.48	2.26	8.29	47.97	22.52	29.51
A12	5-15	23.0	3.50	1.62	4.80	41.12	23.00	35.88
AC1	15-27	16.0	2.21	1.30	5.47	40.93	22.20	36.88
AC2	27-36	17.0	2.13	1.16	5.47	38.76	22.44	38.82
Cca	36-51	17.0	1.73	1.21	6.41	37.11	23.02	39.88
C1	51-66	17.5	1.74	1.67	7.41	31.52	25.34	43.14
C2	66-80	20.0	2.36	1.88	8.51	22.05	30.06	47.90
Ccs	80-104	20.0	2.28	1.91	7.76	16.11	33.50	50.39
Nonsaline Site								
Ap1	0-2	1.13	.28	.07	.25	44.52	22.90	32.59
	2-7	.72	.18	.05	.13	46.36	20.08	33.57
A12	7-14	.69	.21	.06	.05	49.38	20.43	30.20
AC	14-30	.98	.21	.10	.22	46.08	23.47	30.45
Cca1	30-44	2.20	.15	.13	.89	42.89	23.58	33.53
Cca2	44-65	5.00	.30	.26	2.42	38.78	22.71	38.51
Cca3	65-95	10.50	1.36	.80	3.66	32.05	25.64	42.32
D	95-108	14.00	.97	.97	3.81	75.17	13.21	11.63

[1] Electrical conductivity of the soil saturation extract.

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